

the cage. During most of this period this is true for two hours each side of true solar noon, and south of latitude 35° it is true for about three hours.

With h greater than 45° the average value of a for solar and sky radiation, with the sun shining through the top of the cage, exceeds 0.60. With h less than 45° , with the sun shining through the east or west side of the cage, the value of a generally exceeds 0.60, and it will not fall below this value unless θ is a small angle.

Plants far enough back from the south side of the cage to receive solar radiation through the top during the middle of the day will therefore receive about 65 per cent of the total radiation, except when shaded from direct solar radiation by the wooden frame of the cage, and this will average about 18 per cent of the time. During this time they will receive about 8 per cent of the total radiation. Therefore the proportion, A , of the total radiation

the cage should receive on an average at least one-half the total solar and sky radiation, unless it is very close to the south side of the cage, and is considerably south of latitude 40° N.

SUMMARY.

1. Pyrheliometric measurements show that at normal incidence with the wire cloth the wires intercept 0.332 of the solar radiation, or about what we would expect of 16-mesh cloth made of No. 29 wire, American gage.

2. Pyrheliometric measurements show that equation (9) applies for the transmission of solar radiation through a vertical side of the cage, and equation (10) for transmission through the horizontal top of the cage, except for very large incident angles.

3. For the total solar and sky radiation, measurements with a Callendar recording pyrheliometer indicate that

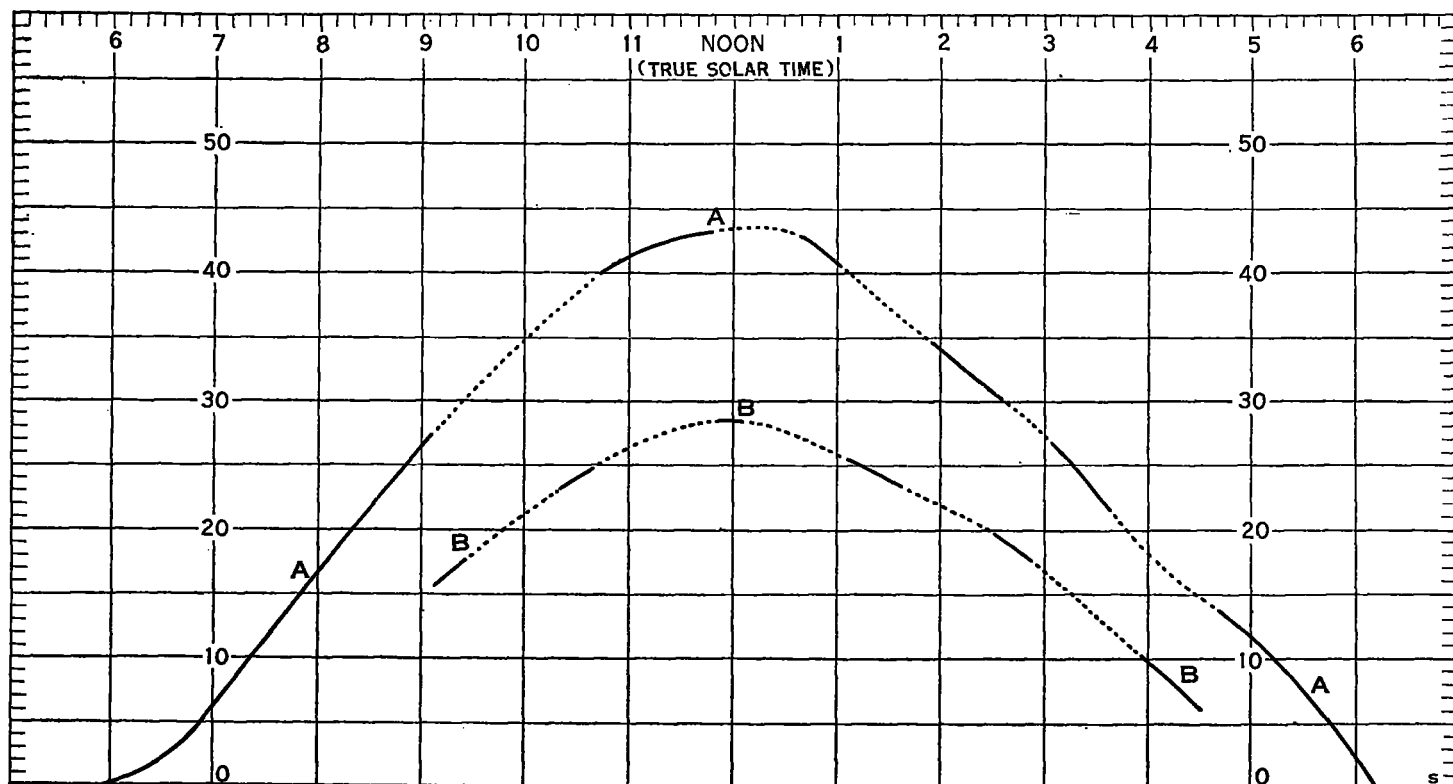


FIG. 3.—Wire insect cage transmission tests, September 20, 1916. Upper curve, A , total solar and sky radiation, measured outside the cage. Intermediate curve, B , radiation measured inside the cage, with sun shining through top.

received by the plant, may be expressed approximately by the equation

$$A = (0.08 \times 0.18) + (0.65 \times 0.82) = 0.55 \quad (13)$$

If the plant is so near the east or the west side of the cage that it does not receive solar radiation through the top of the cage until nearly noon, the transmission for the two hours preceding or following noon may be reduced to about 0.30, and the proportion for the day may be less than 0.50.

If the plant is so near the south side of the cage that it receives its midday solar radiation through this side, the transmission for the four midday hours may be reduced to from 50 to 30 per cent, depending on the values of h and θ .

The lower the latitude the less will be the amount of radiation transmitted through the south side of the screen, and, likewise, the smaller will be the area receiving radiation through this side. Therefore, a plant in any part of

equation (12) gives approximate results, where S is determined from equation (9) or equation (10).

4. From equations (12) and (13), it appears that a plant in any part of the cage, except close to the south side, should receive about 50 per cent of the total radiation.

Equations (1) to (10) can be adapted to wire cloth of any character by changing the constants in equations (1), (2), and (4), which are derived from the mesh of the cloth and the diameter of the wire. Equations (12) and (13), which are at best only approximately correct, are not easily derived mathematically.

CIRCUMZENITHAL ARC WITH A BLACK BAND.

By HOWARD H. MARTIN, Assistant Observer.

[Dated: Fort Worth, Tex., Aug. 12, 1916.]

An exceptional opportunity to make accurate observations of the circumzenithal arc was afforded the writer on the afternoon of August 6, 1916. The phenomenon was

observed from 18^h 34^m to 19^h 06^m, 75th meridian time (17^h 34^m and 18^h 06^m, resp., 90th mer. time). At this station (lat. 32° 43' N.; long. 97° 15' W.) the altitude of the sun varied from approximately 23° to 18° 30'.

The angular measurements were secured by the use of the altazimuth, used by the writer in securing measurements of meteor paths. Although homemade, it has been found accurate and it is believed can be relied upon to within 20' of a true measurement.

The altitude of the sun was measured three times, viz, 18^h 36^m 10^s, 18^h 43^m 05^s, and 19^h 06^m 10^s, 75th meridian time. All other values in Table 1 are interpolated.

The correction necessary at this station to reduce 75th meridian time to local mean solar time is -1^h 29^m.

The radius of the arc was determined by measuring the altitude of the band at its point of maximum convexity, or on a line drawn from the zenith to the sun's position, the complement of this value being the radius value. It has been assumed throughout that the band maintained a constant width of 2°. The minute values have been given to as close a figure as possible and are believed to be within 5' of the true measurement.

The horizontal position of the band was obtained by determining the approximate azimuth of either end. These values can not be trusted to within 5° because of the diffused character of the light at these points.

TABLE 1.

Time, 90th meridian.	Altitude of sun.	Solar distance.	The arc's—	
			Radius.	Limiting azimuths.
H. m. s.	Deg. min.	Deg. min.	Deg. min.	Degrees.
17 36 10	23 00	45 40	21 20	55-85
17 37 10	22 52	45 42	21 26	55-85
17 38 00	22 43	45 42	21 35	58-85
17 39 10	22 34	45 43	21 43	60-86
17 40 20	22 24	45 44	21 52	62-86
17 41 00	22 18	45 44	21 58	65-88
17 42 10	22 09	45 45	22 06	65-88
17 43 05	22 00	45 46	22 14	66-88
17 44 10	21 50	45 46	22 24	68-88
17 45 10	21 42	45 47	22 31	70-88
17 46 00	21 34	45 48	22 38	70-90
17 47 00	21 25	45 49	22 46	74-90
17 48 10	21 16	45 50	22 54	78-90
17 49 20	21 05	45 51	23 05	80-90
17 50 10	20 56	45 51	23 13	82-92
17 55 10	20 12	45 55	23 53	85-92
18 00 00	19 27	46 01	25 31	88-92
18 06 10	18 30	46 09	25 21	90-92

DISCUSSION.

During the time of observation of this arc no evidence in any part of the sky of any other arc, halo, or optical phenomenon was noted. The skies were partly clouded, with about $\frac{1}{2}$ Cu. and A.St. Local showers had occurred in various parts of the county prior to the time of the phenomenon, and a thunderstorm had passed south of the station within an hour previous.

Color.—The band of the arc was highly colored, the red nearest the sun, and at one or two of the observations the violet could be distinguished. The red seemed to be intensified at that point nearest the sun, or on an imaginary line from the sun to the zenith. As the observations progressed, the colors faded, leaving the red in prominence until at the last, 19^h 06^m 10^s, 75th meridian time (18^h 06^m 10^s by 90th mer. time), the phenomenon was little short of a red spot directly west of the zenith.

Dark line.—Beginning with the observation at 18^h 40^m 20^s, 75th meridian time (17^h 40^m 20^s by 90th mer. time), and ending with the observation at 18^h 44^m 10^s (17^h 44^m 10^s by 90th mer. time), a very peculiar phenomenon was observed. The red circumzenithal arc was seen divided

horizontally by a single dark line running the full length of the arc, into two bands whose widths were as 2 : 3, the narrower band being next the sun.

An attempt to photograph this phenomenon was unsuccessful, since the lens of the camera was not suited for the work.

The dark line faded rather abruptly and entirely within the minute elapsing between the observations at 17^h 44^m 10^s and 17^h 45^m 10^s (90th mer. time).

This dark line resembled the dark Fraunhofer lines of the spectrum, and this suggested the idea that it partook of the nature of the telluric spectral lines, which are due to absorption by the gases of our atmosphere. Perhaps some other observer has seen this peculiar line and given a better explanation of it.

ATMOSPHERIC ELECTRICAL VARIATIONS AT SUNSET AND SUNRISE.¹

By E. H. NICHOLS.

[Reprinted from Science Abstracts, Sect. A, Aug. 25, 1916, § 916.]

Observations of the positive and negative charge per cubic centimeter, the air-earth current, and the conductivity were made with two Ebert electrometers and a Wilson compensating gold-leaf electroscope. Potential gradients were measured from the charts of the Kelvin water dropper. The two Ebert instruments were used to record the simultaneous values of the positive and negative charges per cubic centimeter. Three consecutive 5-minute readings were taken immediately before sunrise or sunset and three immediately after. Taking the means of the "15 minutes before" and of the "15 minutes after" sunset, it is apparent that a decrease of about 20 per cent occurs in all the quantities (positive charge, negative charge, air-earth current, and conductivity) at the time of sunset. The individual 5-minute readings show that this is not brought about by a sudden change at the instant of sunset, but by a gradual decrease throughout the whole 30 minutes in all the elements. The effect seems to be as strong in the winter months as in the summer. The sunrise readings show that the effect is not so pronounced at sunrise as at sunset. A similar investigation was carried out on the potential gradient, making use of two years' records from the water dropper. There is generally an increase in potential gradient both at sunrise and sunset. This is well marked in the winter but negligible in the summer. Again there is no sudden change at the instant of sunrise or sunset, but a gradual one throughout the 30 minutes.

The effect was tried of applying a correction for the diurnal variation of potential gradient at the appropriate time of day, and it was found that after doing this the sunrise and sunset effects were still apparent.—J. S. Di[n]es].

IONIZATION OF THE UPPER ATMOSPHERE.²

By W. F. G. SWANN.

[Reprinted from Science Abstracts, Sect. A, June 26, 1916, § 711.]

From various points of view there are indications that the upper atmosphere is to be treated as a region of high electrical conductivity. One of the first theories which took this hypothesis as one of its bases, was that developed by Schuster to account for the diurnal variation of the earth's magnetism.³ There are different sources to which the necessary ionization may be ascribed,

¹ Proc., Royal Soc., London, July 1, 1916, 92:401-408.² Terrestrial magnetism, March, 1916, 21:1-8.³ See Science Abstracts, 1908, § 1158.